REMARKS

Claims 1, 3-12, and 26-32 are pending. Claims 2 and 13-25 were previously canceled. The Examiner presented new grounds of rejection in the latest Office Action.

Applicants' invention is directed to methods for forming a dielectric layer on semiconductor devices that utilize a silicon-containing material for the dielectric layer. In one embodiment, a silicon-containing material comprising a silazane is deposited on a substrate. The deposited material is processed with a reactive agent to react with silicon atoms of the deposited material to form the dielectric layer. The silicon-containing dielectric layer provides improved or smaller semiconductor devices by reducing leakage and increasing the dielectric constant.

In the most recent Office Action, the Examiner rejected claims 1 and 4-8 under "35 USC §102(e) as anticipated by Huang et al in view of Yau et al" (newly-cited) (Paper No. 9, page 2). Because the rejection was placed under the heading "Claim Rejections - 35 USC § 103," because more than one reference was used in the rejection, and because the Examiner asserted obviousness in explaining the rejection, applicants will treat the rejection as being made under 35 USC §103.

Huang et al. discloses a conventional semiconductor fabrication method to form a dielectric structure. Depositing a dielectric layer 120 over a polysilicon electrode 100 forms the dielectric structure. Then a layer of silicon nitride 130 is formed over the dielectric layer 120. The layer of silicon nitride endures a second nitridation process to remove any punctures 132 in the silicon nitride layer 130, thereby producing a smooth silicon nitride layer 130a. The layer of silicon nitride 130a and dielectric layer 120 form a dielectric structure over the electrode 100. Yau et al teach a method of improving the moisture resistance of a low dielectric constant film by depositing a silicon dioxide based film formed from the reaction of an organosilicon compound and an oxidizing gas, exposing the silicon dioxide based film to water or a hydrophobic-imparting surfactant such as hexamethyldisilazane, and curing.

The Examiner made several assertions concerning the teachings of Huang. Specifically, it was asserted that, "it is inherent that exposing polysilicon to the air in [the] depositing chamber causes the silicon-containing material which is deposited on

contact to the surface of the conductive layer" (Paper No. 9, pages 2-3). The Examiner then concluded that it would have been obvious to perform the process of Huang using a silazane as the silicon-containing source as allegedly taught by Yau et al.

The Examiner appears to have asserted that the primitive oxide layer 110/110a that forms on polysilicon conductive layer 100 of Huang et al by exposure to air meets the claim language "depositing a silicon-containing material from a silicon source." He concedes, however, that Huang et al do not disclose depositing a silicon-containing material comprising a silazane. Applicants disagree with the Examiner's assertion that Huang et al deposit a silicon-containing material onto a substrate.

Huang et al simply start with a polysilicon wafer as the substrate, and the surface of the polysilicon becomes oxidized ("primitive oxide layer 110") by exposure to air. See, col. 3, lines 30-33. No other silicon-containing material is deposited, by a vapor deposition process or otherwise. The subsequent first nitridation process (col. 3, lines 47-63) also does not vapor deposit a silicon-containing material. Rather, as described by Huang et al, the remaining primitive oxide layer 110a, after etching, is converted into a dielectric layer by exposure to a nitrogen-containing gas or plasma. Because Huang et al form the primitive oxide layer and subsequent dielectric layer by reactions with silicon *already present* on the wafer surface, Huang et al do not teach or suggest the process claimed in claims 1 and 4-8.

Applicants also do not understand the Examiner's statement that "it is inherent that exposing polysilicon to the air in the depositing chamber causes the silicon-containing material which is deposited on contact to the surface of the conductive layer 100" (Paper No. 9, pages 2-3). If the Examiner is saying that exposing the polysilicon layer 100 of Huang et al to air causes a primitive oxide to form by the reaction of oxygen with silicon *already present* on the substrate, then applicants agree that this is what Huang explicitly teaches at col. 3, lines 30-33. However, if the Examiner is saying that *additional* silicon-containing material is deposited out of the air, then applicants vigorously disagree. There is simply no deposition of a silicon-containing material onto Huang's electrode 100.

Nor could the teachings of Huang et al and Yau be combined as proposed by the Examiner because Huang et al does not form dielectric layer 120 by any deposition process and Yau simply exposes an existing oxide layer to a "hydrophobic-imparting surfactant." Yau does not utilize a silazane as the *deposited* material for forming a dielectric layer as alleged by the Examiner. Rather, Yau's dielectric layer is formed from an organosilane or organosiloxane. See, col. 5, lines 4-65.

With respect to claims 4-8, the Examiner concedes that neither Huang nor Yau teach or suggest a reactive agent selected from NH_3, N_2, O_2, N_2O, and NO, or utilize a silicon source comprising a self-limiting hexamethyldisilazane source. Nor do the references teach or suggest the thickness of the dielectric layer in claim 8. The Examiner, without citing to any prior art, simply asserts that all such claimed features are obvious. The Examiner is reminded of the requirements of 37 CFR §1.104(d). Applicants challenge the Examiner's unsupported assertions. If the Examiner persists in this ground of rejection, applicants request that the Examiner either cite a proper prior art reference as evidence of his assertions or make a declaration. For all of these reasons, the rejection of claims 1 and 4-8 is not well taken and should be withdrawn.

Also in the Office Action, the Examiner apparently rejected claim 3 under 35 USC §103 as unpatentable over Huang et al in view of Yau et al. However, the reasoning for the rejection appears to be the same as that used to reject claim 1. Applicants submit that claim 3, which recites a Markush group of silazane compounds as the deposited silicon-containing material, is patentable for the same reasons that claim 1 is patentable. Applicants repeat and incorporate by reference all of the arguments set forth above with respect to the rejection of claim 1. Huang et al do not deposit a silicon-containing material, and the teaching of Huang et al and Yau are not combinable.

Also in the Office Action, the Examiner rejected claims 9-11 under 35 USC §103 as unpatentable over Huang et al in view of Yau et al. Independent claim 9 recites "vapor depositing a silicon-containing material from a silazane source." The Examiner asserts, without any specific reference to any teaching in Huang, that Huang teaches such a vapor deposition. Applicants strongly disagree.

If the rejection is based on the assertion that the deposition of polysilicon layer 100 in Huang et al's process is supposed to meet the claim language of "vapor depositing a silicon-containing material," then the Examiner is simply mistaken as to what Huang teaches. Nothing in Huang et al teaches or suggests that the polysilicon layer 100 is to be vapor deposited. And, one skilled in the art would not attempt to form **a conductive layer** 100 using a silazane. The rejection falls apart because Huang et al do not teach or suggest a separate vapor deposition of silicon-containing material to form a dielectric layer. Rather, a temporary dielectric layer form because of the primitive oxide that forms on the already deposited polysilicon. The final dielectric layer is formed by a series of nitridation steps. For all of these reasons, applicants submit that claims 9-11 are patentable over the art.

In the Office Action, claim 12 was rejected under 35 USC §102(e) as anticipated by Huang et al. Again the Examiner asserted that Huang teaches vapor-depositing a silicon-containing material from a self-limiting silicon source. Huang teaches neither. The portion of Huang to which the Examiner refers, col. 4, lines 4-10, does not refer to the polysilicon layer 100. Rather, that portion of Huang discusses the subsequent formation of a silicon nitride layer 130 over dielectric layer 120. Nor is Huang's polysilicon substrate a self-limiting source. Depending on the oxidizing conditions to which the polysilicon layer 100 is exposed, primitive oxide layers of varying thicknesses could be formed from the essentially unlimited supply of silicon in the polysilicon substrate. Huang et al fail to teach or suggest the claimed invention. Claim 12 is patentable over Huang et al.

Also in the Office Action, the Examiner rejected claims 26-30 under 35 USC §103 as unpatentable over Huang et al in view of Yau et al. The rationale for the rejection is the same as that asserted by the Examiner to reject the other pending claims. Applicants submit that claims 26-30, which recite depositing a silicon-containing material from a silicon source comprising a silazane are patentable for the same reasons that claims 1 and 4-12 are patentable. Applicants repeat and incorporate by reference the arguments set forth above with respect to this rejection. Huang et al do not deposit a silicon-containing material and the teachings of Huang et al and Yau are not combinable.

Also in the Office Action, the Examiner rejected claims 31-32 under 35 USC §103 as unpatentable over Chew et al in view of Nishio. The Examiner asserted that Chew et al teach a process in which a silicon-containing material is vapor deposited over a substrate. The Examiner conceded that Chew et al did not teach or suggest the use of a silazane, but asserted that Nishio et al did and that it would have been obvious to use a silazane in the process of Chew et al.

However, the vapor deposition passage in Chew et al referenced by the Examiner (col. 3, lines 55-63) is directed to an alternative embodiment where the substrate material is not polysilicon. In this alternative embodiment, Chew et al combine a silicon-containing gas with nitrogen plasma to form silicon nitride in a single step and at relatively low temperatures (i.e., 300 to 500°C). Thus, Chew et al do not teach or suggest a process that includes vapor deposition of a silicon-containing material comprising a silazane followed by rapid thermal nitridization (RTN) of the deposited layer. Even if it would have been obvious to use a silazane in the Chew et al process, the claimed process would not result because Chew et al teach a single step process using high density plasma (HDP) to form silicon nitride. The Examiner's reference to col. 4, lines 15-30 of Chew et al does not relate to a rapid thermal nitridization process. Rather, the silicon nitride is deposited from the gas phase directly onto the substrate. For all of these reasons, the rejection of claims 31-32 is not well taken and should be withdrawn.

For all of the above reasons, applicants submit that claims 1, 4-12, and 26-32 are patentable over the cited and applied art of record. Early notification of allowable subject matter is respectfully solicited.

Respectfully submitted,

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